

APPLICATION		REVISIONS			
NEXT ASSY	FINAL ASSY	LTR	DESCRIPTION	DATE	APPROVED
		A	PRODUCTION RELEASE/E.O. 40079	1-31-07	B4/0

VACUUM FLUORESCENT DISPLAY
2 X 20 CHARACTER
S03601-30-040R

REV	A	A	A	A	A	A	A	A	A	A	A	A	A											
SHEET	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

REVISION STATUS


PROJ. NO. 246	CONTRACT		 INDUSTRIAL ELECTRONIC ENGINEERS, INC. VAN NUYS, CALIFORNIA	
<small>NOTICE IS HEREBY GIVEN THAT THIS DRAWING IS PART OF A PROPRIETARY ITEM OWNED BY INDUSTRIAL ELECTRONIC ENGINEERS, INC. AND SHALL NOT BE REPRODUCED, OR COPIED OR USED AS THE BASIS FOR MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION OF I.E.E. INC.</small>	DRAWN	R. Rabb	VACUUM FLUORESCENT DISPLAY 2 X 20 CHARACTER	
	CHECK	<i>B4/0</i> 1/31/07		
	APPROVED <i>B4/0</i> 1-31-07		SIZE A	CODE IDENT NO. 05464
	APPROVED		SCALE	SHEET 1 OF 14

TABLE OF CONTENTS

PARAGRAPH NUMBER & TITLE

1.0	GENERAL DESCRIPTION
1.1	Introduction
1.2	Application
1.3	Special Features
1.4	Description
2.0	BLOCK DIAGRAM
3.0	THEORY OF OPERATION
4.0	OPERATION
4.1	Loading ASCII Character Data
4.2	Control Codes
4.3	Character Chart
4.4	Alternate Character Codes
4.5	Hardware Reset
4.6	Execution Times
4.7	Serial Data and Self-test
4.8	Connector Pin Assignments
5.0	ELECTRICAL CHARACTERISTICS
5.1	Power ON / OFF Sequence
5.2	Interface Signals
5.3	Absolute Maximum Ratings
5.4	Normal Operating Ratings
6.0	OPTICAL CHARACTERISTICS
7.0	ENVIRONMENTAL CHARACTERISTICS
8.0	ACCESSORIES
9.0	OUTLINE & INSTALLATION DRAWING

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R	
	SCALE	N/A	REV A	SHEET 2

1.0 GENERAL DESCRIPTION

1.1 Introduction

This specification describes the interface requirements and features of a 2 line Vacuum Fluorescent Display, 20 characters wide. The characters are formed using a 5x7 dot matrix.

1.2 Application

This unit may be used as a console display which provides alphanumeric information that is easily readable in high ambient light. It is ideal for point-of-sale terminals, office computers, and a wide range of business and industrial equipment.

1.3 Special Features

Minimum footprint	Hardware reset
Minimum depth	Software dimming
ECMA-7 character alternates	Large characters – 11.3mm
Serial interface at 1200 or 9600 baud	RoHS Compliant
RS-232C with CTS and DTR	
Bidirectional RS-422 Compatible	

1.4 Description

The 2 x 20 Flip display is a self-contained multiplexed unit which provides a simple serial interface to a host system.

This unit consists of a vacuum fluorescent display tube with a minimal amount of electronic hardware. Primary complexity is contained within the microprocessor software, which controls all display functions.

A single +5VDC power supply (approximately 700mA typical for brightest setting) is required for operation. Total power is thus about 3.5 watts.

A wide spectrum of color filters is available to fit all applications. The characters are bright, but soft, providing comfortable short or long-term viewing.

The Flip alphanumeric display uses vacuum fluorescent technology to display characters in a 5 X 7 dot matrix. All display characters and standard control codes are in 7-bit ASCII. An ASCII-coded English font employs a standard 96 character set.

Figure 3 depicts the standard ASCII and Greek character set as displayed by the 03601-30-040R module.

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R	
	SCALE	N/A	REV A	SHEET 3

2.0

BLOCK DIAGRAM

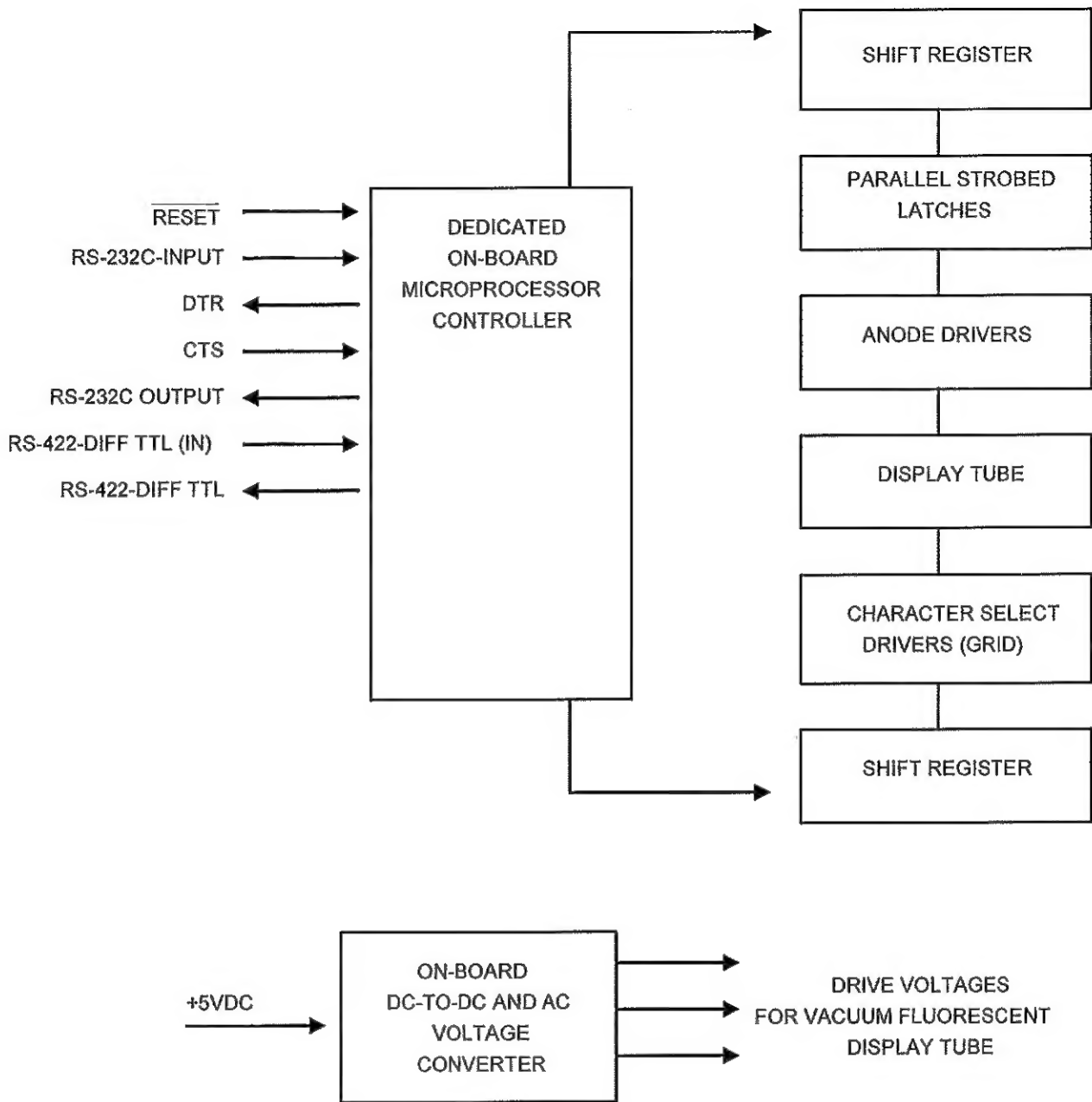


FIGURE 1

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R
	SCALE N/A	REV A	SHEET 4

01/30/07

3.0 THEORY OF OPERATION (Dot Matrix Displays)

The Vacuum Fluorescent Display array consists of three basic electrodes which are enclosed in an evacuated glass chamber. The first electrode is the filament, which spans the entire length of the display, and is made from a small diameter oxide coated tungsten wire. This element is common to all characters and supplies the electron emission needed for operation. Individual grid electrodes are provided, one for each character, to control current passing to the anodes. Each grid is a fine mesh metal screen which provides digit-select electrical control with no visual interference. When the grid is positive with respect to the filament, electrons are allowed to pass on to the third electrode, the anode dots, causing the fluorescent phosphor coating on each positively charged dot to glow. Selectively energizing these fluorescent dots causes the desired character to be displayed.

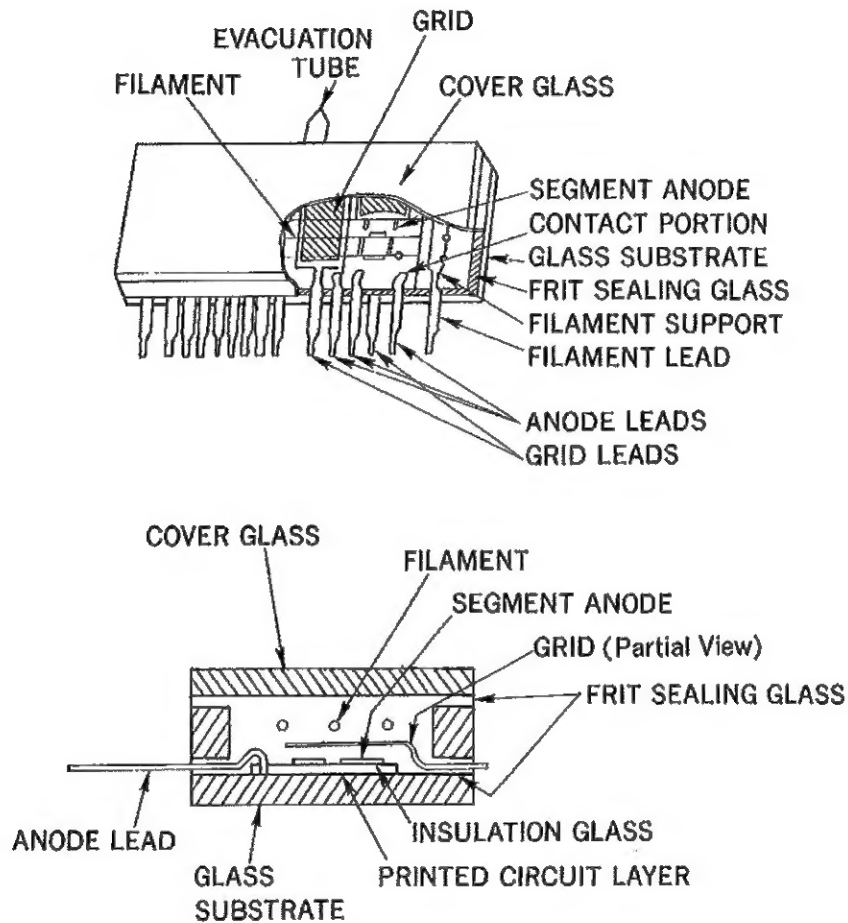


FIGURE 2

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R
	SCALE	N/A	REV A
			SHEET 5

4.0 OPERATION

4.1 Loading ASCII Character Data

All printing characters are located in standard ASCII code locations from 20 (HEX) to 7F (HEX). Control character assignments are as follows.

4.2 Control Codes

NOTE: CARE SHOULD BE TAKEN NOT TO SEND UNDEFINED CONTROL OR COMMAND CODES TO THE FLIP DISPLAY MODULE AS THIS MAY CAUSE A SOFTWARE MALFUNCTION OF THE MODULE. WHEN USING HANDSHAKE, SEND CODES ONLY WHEN DTR IS HIGH. WHEN NOT USING HANDSHAKE, REFER TO EXECUTION TIMES IN SECTION 4.6.

DATA (HEX)	DESCRIPTION
04	* PREPARE TO READ DATA AT PRESENT CURSOR LOCATION
05	* PREPARE TO READ CURSOR LOCATION VALUE
08	BACK SPACE CURSOR LOCATION ONE POSITION
09	ADVANCE CURSOR LOCATION ONE POSITION
0A	LINE FEED
0B	BEGIN CHARACTER BLINK FIELD
0C	END CHARACTER BLINK FIELD
0D	CARRIAGE RETURN (returns cursor to left-most character position of the same line; does not clear display)
0E	MAKE CURSOR INDICATOR INVISIBLE (the cursor location counter continues to function but there is no visible indicator of next character location)
0F	+ MAKE CURSOR INDICATOR VISIBLE (this is a blinking indicator of where the next character will be located)
<10>	BOTTOM LINE DATA ENTRY WITH AUTOMATIC CARRIAGE RETURN & LINE FEED (data enters beginning at the left-most character position of the bottom row)
<11>	+ NORMAL DATA ENTRY WITH AUTOMATIC CARRIAGE RETURN AND LINE FEED
<12>	OVERWRITE OF RIGHT-MOST CHARACTER / AUTOMATIC CARRIAGE RETURN OFF (right-most character on current line)
<13>	HORIZONTAL SCROLL MODE (from right to left on bottom line only after line has been filled)
14	RESET

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R	
	SCALE	N/A	REV A	SHEET 6

4.2 Control Codes (Cont'd)

DATA (HEX)	DESCRIPTION
15	+ DISPLAY CLEAR (puts cursor at left side bottom row in Mode 10 HEX, & home in Modes 11 HEX, 12 HEX and 13 HEX).
16	+ CURSOR HOME (returns cursor to upper left-most position)
19	FIRST BYTE OF CERTAIN MULTIBYTE COMMANDS
[1A]	SELECT SCIENTIFIC CHARACTER SET
[1C]	+ SELECT ENGLISH CHARACTER SET (U.S. ASCII-7)
[1D]	SELECT GENERAL EUROPEAN CHARACTER SET (ECMA-7)
[1E]	SELECT SCANDINAVIAN CHARACTER SET (ECMA-7)
[1F]	SELECT GERMAN CHARACTER SET (ECMA-7)
20-7F	CHARACTER SET (see CHARACTER CHART)
<p>* "PREPARE TO READ. . ." commands should be followed with a "READ DATA FROM DISPLAY MODULE" operation, which is accomplished by pulsing RD low when A₀=0 and CS=0. See Section 4.3.</p> <p>+ Display automatically defaults to these conditions after power-up and reset.</p> <p>< > These instructions are mutually exclusive</p> <p>[] Character set control affects ASCII characters 5B, 5C, 5D, 5F, 23 & 60.</p>	

Additional commands may be written preceded by 19 HEX. They are as follows:

DATA (HEX)	DESCRIPTION
00XX XXXX	MOVE CURSOR TO LOCATION XX XXXX (Location in binary – "0000 0000" moves cursor to left-most position)
40	RESET
41	* PREPARE TO READ CURSOR LOCATION VALUE
42	* PREPARE TO READ DATA AT PRESENT CURSOR LOCATION
43	* PREPARE TO READ DATA AT PRESENT CURSOR LOCATION AND INCREMENT CURSOR

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R	
	SCALE	N/A	REV A	SHEET 7

4.2 Control Codes (Cont'd)

DATA (HEX)	DESCRIPTION
------------	-------------

4C	+ DISPLAY DIMMEST
----	-------------------

4D	DISPLAY DIM
----	-------------

4E	DISPLAY BRIGHT
----	----------------

4F	DISPLAY BRIGHTEST
----	-------------------

50	NEXT CHARACTER WILL HAVE PERIOD ATTACHED
----	--

51	NEXT CHARACTER WILL HAVE COMMA ATTACHED
----	---

*	When DTR is high send 19H to unit's RXD. When DTR is high send read code (04H, 05H, 41H, 42H, 43H) to unit's RXD. Set CTS high. Receive data via unit's TXD. Repeat as required.
---	--

+	Display automatically defaults to these conditions after power-up and reset.
---	--

NOTE: For interface configuration not using handshake (such as RS-422), connect CTS to VCC or high level voltage.

4.2.1 Cursor Positioning Instruction

DATA (HEX)	DESCRIPTION
------------	-------------

1B HEX (0001 1011)	MOVE CURSOR TO FOLLOWING POSITION (2-byte instruction to locate the cursor)
-----------------------	--

XLXX XXXX	SECOND BYTE (Location in binary – left most location is zero. L=0 upper line, L=1 lower line)
-----------	--

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R
	SCALE	N/A	REV A SHEET 8

4.4 Character Chart (5x7 Dot Matrix)































N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F
40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F

FIGURE 3

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R	
	SCALE	N/A	REV	A SHEET 9

4.4 Alternate Character Codes

1A, 1C-1F are mutually exclusive latched functions. The following characters appear as a function of the last control code (1A, 1C-1F) and their ASCII location.

CONTROL CODES	CHARACTER SET	ASCII LOCATION (HEX) CHARACTERS					
		23	5B	5C	5D	5F	60
1A	Scientific						
1C	English						
1D	General European						
1E	Scandinavian						
1F	German						

Default at power-up is 1C (English)

NOTE: Hardware or software reset restores any altered character to the 1C English character set.

4.5 Hardware Reset

4.5.1 RESET

Hardware RESET is available on J1 (power), pin 6. Holding RESET low for at least 15mS, and then returning it to high, will clear the display and set the cursor to the home position (power-up condition); this sequence requires approximately 1 second to complete. Sinking current must be able to sink a 10K resistor connected to Vcc internally.

4.5.2 Automatic Reset

The display module contains sophisticated power monitoring circuitry. The VCC is monitored and the microprocessor held in reset until VCC input exceeds 4.5VDC or 4.75VDC depending on jumper selection. If VCC drops below the selected level even briefly, or if the microprocessor program operation is not normal, the display module will automatically reset the microprocessor.

4.6 Execution Times (Maximum)

Character (and Control Codes) Rate: 1200 or 9600 Baud

Reset (Hardware): 1 second

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464		S03601-30-040R	
	SCALE	N/A	REV A	SHEET	10

4.7 Serial Data and Self-test

4.7.1 Serial Interface

The 2 X 20 Flip display has two interface options available:

INPUT/OUTPUT

LINE RECEIVE/LINE DRIVER

1) RS-232C

MAXIM MAX232

2) RS-422

TEXAS INSTR. ALS180

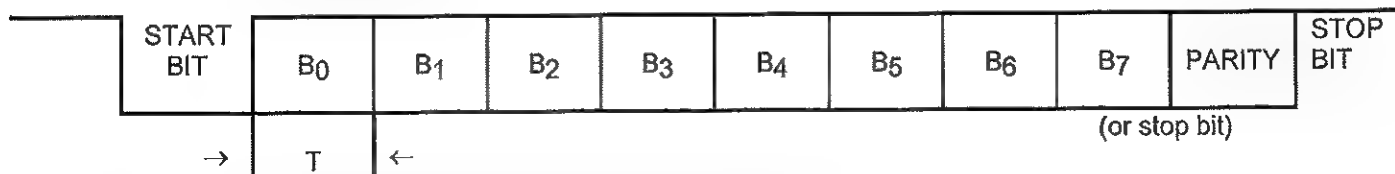
4.7.2 Transmit and Receive Data Configuration and Rate

A set of jumpers on the 2X20 display control board allows the user to select a data rate of 1200 or 9600 baud. Parity is also selectable for odd even, with one stop bit or no parity with two stop bits. Jumper selection for a desired data format is as follows:

4.37 ± 0.12 Volt Reset Tolerance	(E6) ()	(E12)	4.62 ± 0.12 Volt Reset Tolerance
Normal Operation	(E5) ()	(E11)	Burn-In Test
Normal Operation	(E4) ()	(E10)	Self-test
Odd Parity	(E3) ()	(E9)	Even Parity
Enable Parity 1 Stop Bit	(E2) ()	(E8)	Disable Parity 2 Stop Bits
9600 BAUD	(E1) ()	(E7)	1200 BAUD

Normally shipped from the factory in this configuration

Input and output word for the 2 x 20 Flip display is 7 data bits with, odd, even or no parity, and one stop bit (2 stop bits if no parity).



T = 833μS when baud rate equals 1200 bits/sec.

T = 104.1μS when baud rate equals 9600 bits/sec.

(EACH CHARACTER IS 10 DATA BIT INTERVALS IN LENGTH)

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R	
	SCALE	N/A	REV A	SHEET 11

4.7.3 Error Detection

The 2 x 20 Flip display is able to detect errors in data transmission. Each character received with an error is replaced with the error symbol "#". An error is detected if data rate is distorted by more than 5%, or if parity is incorrect.

4.7.4 Signal Definition

RXD (INPUT) – Receive Data: RS-232C, J2-3. Serial data signals from the host computer are sent to the receive data port of the Flip display.

DTR (OUTPUT) – Data Terminal Ready: RS-232C, J2-20. The display module will not accept data when DTR is low.

TXD (OUTPUT) – Transmit Data: RS-232C, J2-2. Serial data signals output from display to the receive data port of the host computer.

CTS (INPUT) – Clear To Send: RS-232C, J2-5. Flip display will output data on TXD only if CTS is high. If CTS is not used, jumper J2, pin 5 to J2, pin 9 on DB-25 so it will be high.

DIFFERENTIAL TTL (RECEIVE) +/-: J2-15, J2-17 (RS-422): Polarity sense for differential TTL operation.

DIFFERENTIAL TTL (TRANSMIT) +/-: J2-11, J2-18 (RS-422): Polarity sense for differential TTL operation.

NOTE: RS-232C and TTL reference ground must be connected to J2-7

4.7.5 Self-test

The 2 x 20 Flip Display may be evaluated on a stand-alone basis by moving the jumper on E4 to E10. Upon initiation of self-test, the display module will execute a "Display Test". The following sequence will be displayed when the display module enters the self-test mode. User can terminate self-test at any time during the test by reconnecting the jumper on E10 to E4.

"DISPLAY TEST"
"SOFTWARE #XXXXX-XX"
"XXXX BAUD"

Depending on jumper settings, one of the following messages will appear:

"7 DATA BITS, NO PARITY"
"7 DATA BITS, ODD PARITY"
"7 DATA BITS, EVEN PARITY"

At this time the display module will perform a "BRIGHTNESS TEST" to check for different stages of brightness (Dimmest, Dim, Bright, and Brightest).

After the above sequence has been completed, ASCII characters from 20 (HEX) to 7F (HEX) will be displayed advancing through the character field at approximately a 3 character per second rate. After the above procedures have been completed, the display will read "READY", after which the display will show incoming data in HEX format.

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R
	SCALE	N/A	REV A
			SHEET 12

4.0 CONNECTOR PIN ASSIGNMENTS

J1 (POWER)

PIN. NO.	FUNCTION
J1-1	+5VDC @ 700mA (typ) +
J1-2	NO CONNECTION
J1-3	NO CONNECTION
J1-4	COMMON
J1-5	NO CONNECTION
J1-6	RESET

+FOR BRIGHTEST SETTING

J2 (DATA)

PIN NO.	FUNCTION
J2-1	CHASSIS GROUND
J2-2	TRANSMIT DATA (RS-232C)
J2-3	RECEIVE DATA (RS-232C)
J2-4	NO CONNECTION
J2-5	CLEAR TO SEND (RS-232C)
J2-6	NO CONNECTION
J2-7	SIGNAL GROUND
J2-8	NO CONNECTION
J2-9	+10V OUT (1K INT. SERIES RES.)
J2-10	-10V OUT (1K INT. SERIES RES.)
J2-11	TX- (RS-422)
J2-12	NO CONNECTION
J2-13	NO CONNECTION
J2-14	NO CONNECTION
J2-15	RX+ (RS-422)
J2-16	NO CONNECTION
J2-17	RX- (RS-422)
J2-18	TX+ (RS-422)
J2-19	NO CONNECTION
J2-20	DATA TERMINAL READY (RS-232C)
J2-21	NO CONNECTION
J2-22	NO CONNECTION
J2-23	NO CONNECTION
J2-24	NO CONNECTION
J2-25	NO CONNECTION
J2-26	NO CONNECTION

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R
	SCALE N/A	REV A	SHEET 13

4.10 Connector Pin Assignments (Continued)

CMOS Note: Care must be taken to insure that input signals do not exceed the supply voltage or ground levels. Data cables must be as short as possible to reduce signal overshoots.

5.0 ELECTRICAL CHARACTERISTICS

5.1 Power ON / OFF Sequence

There are no deleterious effects associated with power ON and OFF of this display; however, rapid ON/OFF sequencing is not recommended. Neither data nor power connectors should be connected/disconnected while power is applied.

CAUTION: Do not apply data or strobe signals unless logic power is also applied; otherwise, the input circuits may be damaged.

Because of the power-up cycle within the microprocessor, rise time of the power supply should be less than 100mS. The display module is not ready to accept data for approximately 1 second.

5.2 Interface Signals

All logic signals abide by the following convention:

Logic "1" is a high, Logic "0" is a low.

RS-422 Levels:	RS-232C Input Levels:	RS-232C Output Levels
Logic 1 > 2.4VDC @ 1uA	Logic 1 (MARK) < -3VDC	Logic 1 (MARK) < -6VDC
Logic 0 < 0.5VDC @ 0.5mA	Logic 0 (SPACE) > +3VDC	Logic 0 (SPACE) > +6VDC

5.3 Absolute Maximum Ratings

Primary voltage: +5.5VDC
Logic range: -0.5VDC thru +5.5VDC
RS-232C: +25VDC to -25VDC
RS-422: +15VDC to -15VDC

5.4 Normal Operating Ratings

Primary voltage: +5.0 ± 0.25VDC

Dimmest
580mA Min. (Screen clear at 5.0V)
590mA Typ. (Screen filled with "A" character at 5.0V)

Brightest
660mA Min. (Screen clear at 5.0V)
700mA Typ. (Screen filled with "A" character at 5.0V)
750mA Max. (Screen filled with "A" character at 5.25V)

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R	
	SCALE	N/A	REV A	SHEET 14

6.0

Projected life at rated
operating conditions: 40,000 to 100,000 hours*

***Note:** End of useful life is defined as the point when the display tube light output has decreased to half its initial minimum rated brightness. This life rating is based on use with random text messages. To obtain maximum life, users are encouraged to avoid fixed messages and to blank or clear the display when it is not in use.

7.0

Operating temperature:	0 to +55 (°C) +32 to +131 (°F)
Storage temperature:	-40 to +85 (°C) -40 to +185 (°F)
Relative humidity:	0 to 95% (non-condensing)
Vibration:	10 to 50 Hz 2mm peak-to-peak (3 axis)
Shock:	20 G (3 axis)
Weight:	14 ounces (397 grams)

8.0

Cables	Part Number	Qty Required
Power	25387-XX*	1
Data (Connector only)	26746-01	1

*XX = Length in inches: -99 omits cables

Filters	P/N 30442-XX
Gray	-01
Blue	-02
Aqua	-04
Neon Yellow-Orange	-05
Green	-07
Neutral Gray CP	-09
Yellow CP	-10

Connectors	Mates With:
Power	Molex 09-50-3061
Data	ITT Cannon DB25P

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R
	SCALE N/A	REV A	SHEET 15

9.0 OUTLINE AND INSTALLATION DRAWING

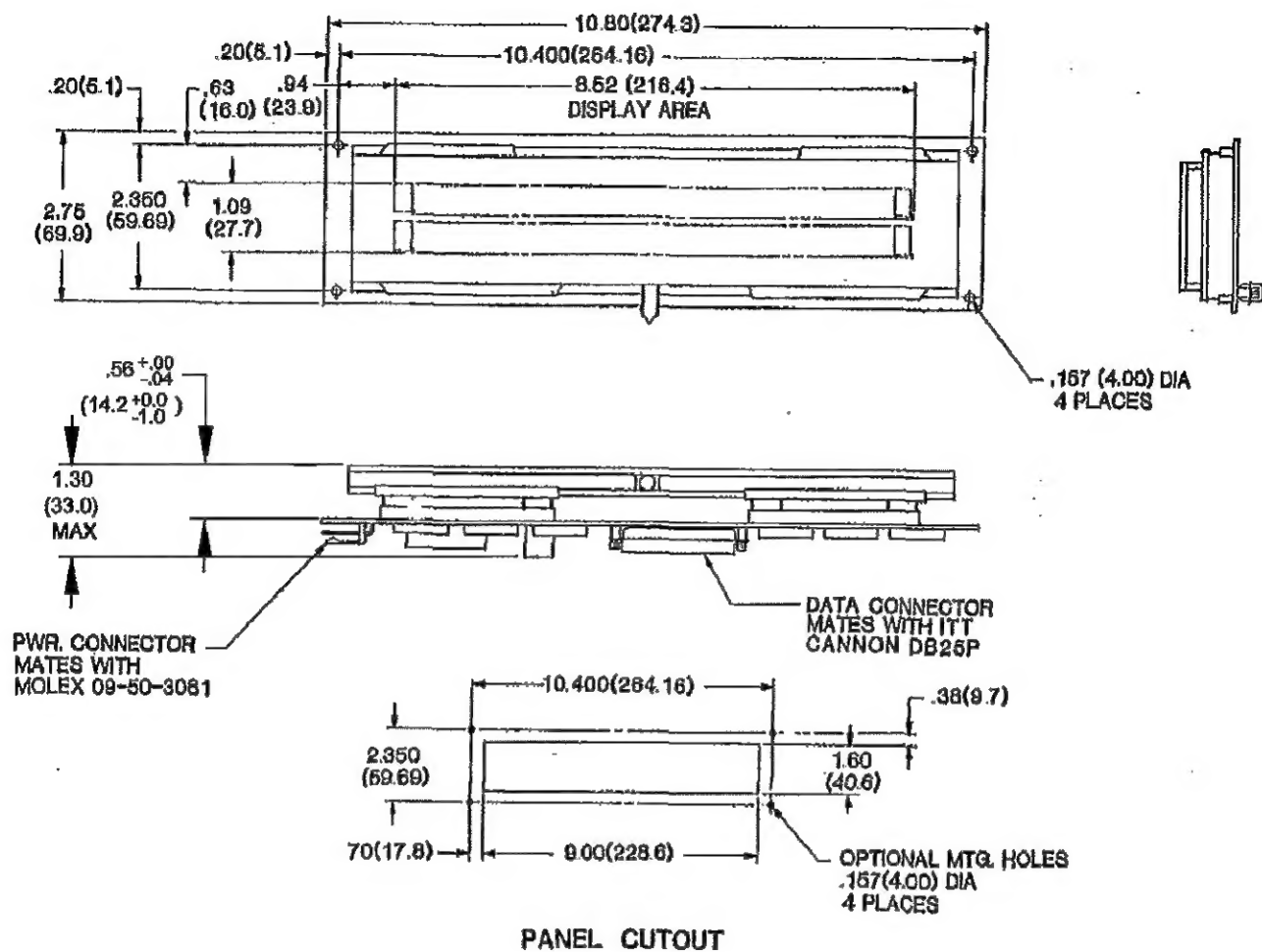


FIGURE 4

TOLERANCE:

$$.XX = \pm .03 \text{ (0.8)}$$
$$.XXX = \pm .010(0.25)$$

Dim. in inches (mm)

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	S03601-30-040R
	SCALE N/A	REV A	SHEET 16